TOPOGRAPHY OF THE YUCCA MOUNTAIN SITE

The purpose of this activity is to demonstrate the usefulness of topographic maps and to examine the topography of the Yucca Mountain site by using a U.S. Geological Survey 7-1/2 minute topographic map. By participating in the exercises, you will acquire a detailed knowledge of the Yucca Mountain site and an understanding of the size and depth of the potential repository. You will also use prominent features on the map to aid you in thinking about guidelines for evaluating potential repository sites that apply to hydrology, erosion, population density and distribution, and site ownership and control.

Directions: Use the U.S. Geological Survey 7-1/2 minute topographic map titled Busted Butte, Nevada, 1961, photo-revised 1983 to answer the questions below.

Reviewing Map Skills

1. Determine the scale and contour interval of the map.

   Scale: *(1:24,000)*

   Contour interval: *(20 feet)*

2. What does 1" on this map represent on the ground? (Show the answer both in inches and converted to feet.)

   (One inch on the map represents 24,000 inches on the ground; this is equal to 2,000 feet.)

3. Locate the information that shows the direction of true north and magnetic north on the map. Where is the information located on the map?

   (It is located in the bottom margin to the left of the scale.)

4. What are the latitude and longitude coordinates of the southeast and northwest corners of the map?

   (Southeast—latitude N36° 45', longitude W116° 22' 30"

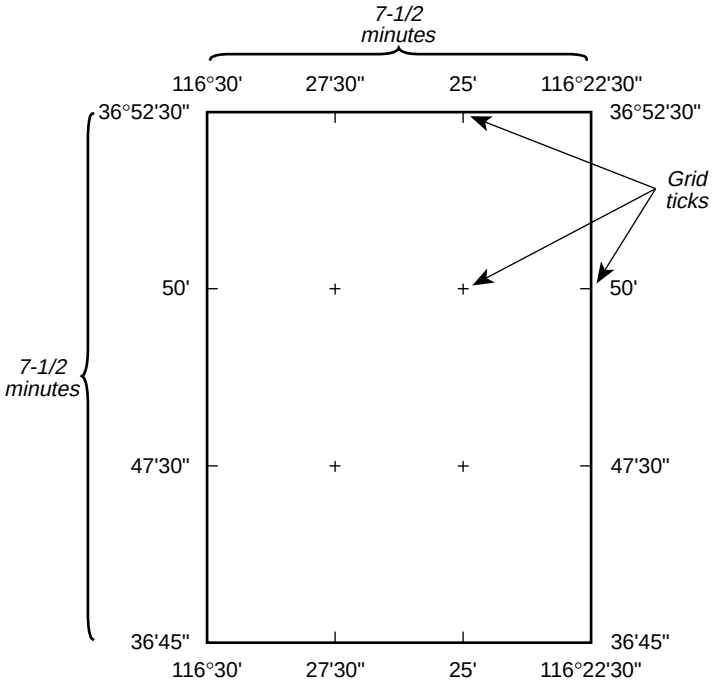
   Northwest corner—latitude N36° 52' 30", W116° 30')

5. What is the purpose of the latitude and longitude grid ticks? List each set of grid ticks separately. (See Figure 1.)

(The latitude and longitude grid ticks divide the map into nine 2-1/2-minute by 2-1/2-minute sections. They are used to help locate or find the coordinates of any point on the map.)

Latitude Grid Ticks: *(N36° 50', N36° 47' 30")*

Longitude Grid Ticks: *(W116° 27' 30", W116° 25')*



Grid ticks divide a 7-1/2-minute map into 2-1/2-minute sections

Figure 1

Part A: Locating A Point On A Topographic Map

Directions: Use the map, an appropriately scaled ruler, and the following latitude/longitude coordinates to locate two points on the map. You will locate each point by finding where a line of latitude and a line of longitude cross.

Point 1: Lat N36° 50' 44", Long W116° 29' 34"

Point 2: Lat N36° 51' 12", Long W116° 23' 28"

Point 1

1. Point 1 falls on Lat N36° 50' 44". Between which orienting points of latitude (grid ticks and/or map borders) does point 1 fall?

   (N36° 50' and N36° 52' 30")

   Draw a line through the necessary orienting point(s) to separate this section of latitude from the rest of the map. (See Figure 2.)

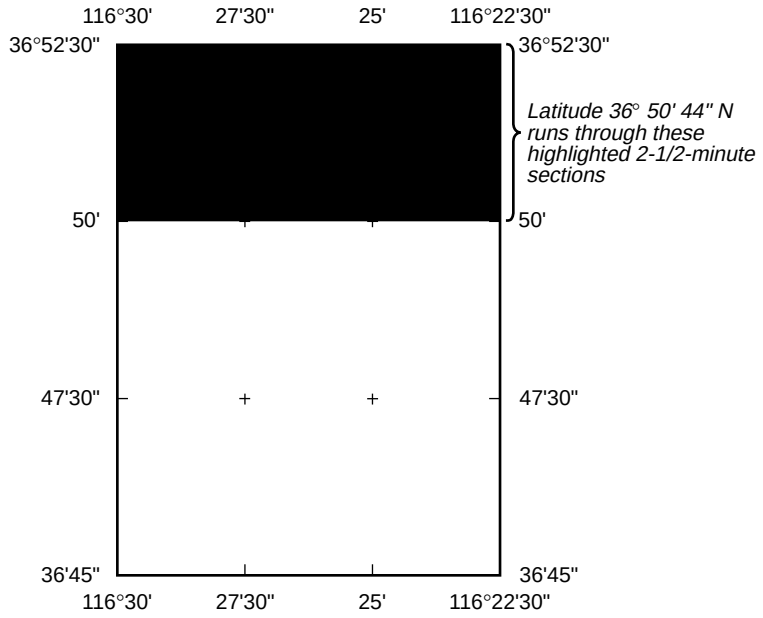


Figure 2

2. Point 1 falls on Long W116° 29' 34". Between which orienting points of longitude does point 1 fall?
(W116° 30' and W116° 27' 30")

_____

_____

Draw a line through the necessary orienting point(s) to separate this section of longitude from the rest of the map. (See Figure 3.)

At this point, one section of the map should be separated from the rest of the map. This section is 1/9th of the whole quadrangle map and it contains point 1. (See Figure 4.)

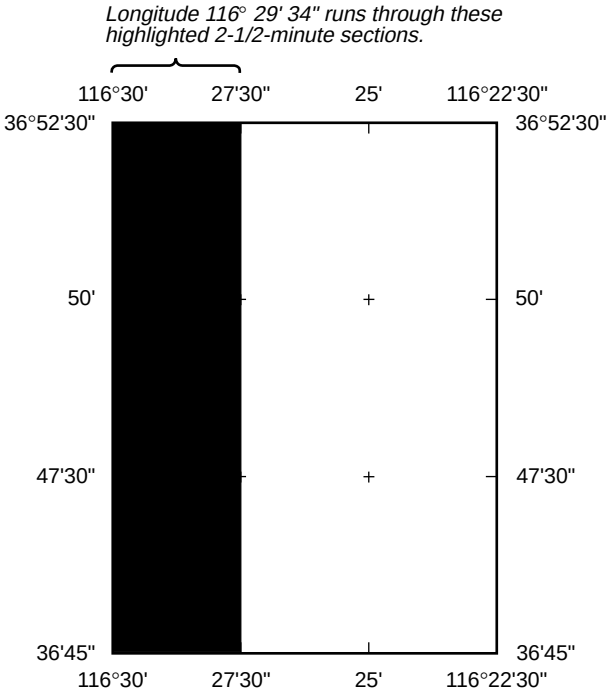


Figure 3

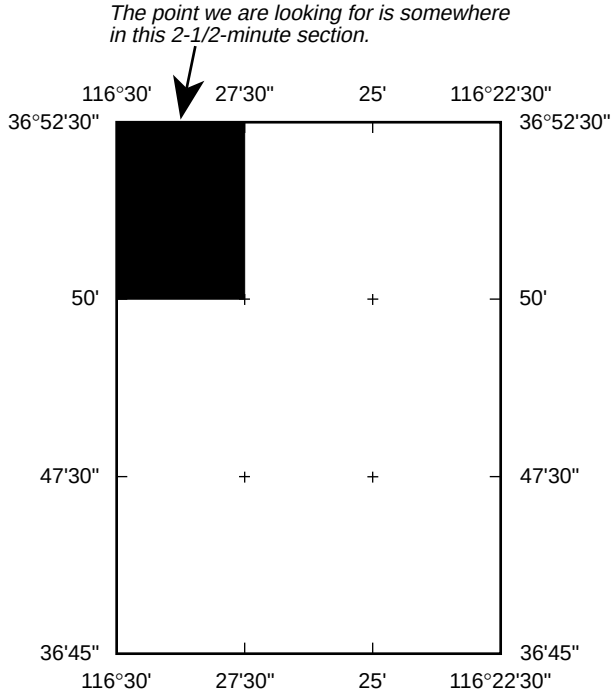


Figure 4

3. In which section of the map will you find point 1?

NW	NC	NE
WC	C	EC
SW	SC	SE

(The NW section.)

_____

_____

_____

_____

4. What are the dimensions of this section of the map in minutes? Convert to seconds.

   Minutes *(2-1/2 minutes x 2-1/2 minutes)*

   Seconds *(150 seconds x 150 seconds)*

5. How many seconds north of the N36° 50' line of latitude is N36° 50' 44"?

   (36° 50' 44" - 36° 50' = 44")

6. Use the engineer's rule or cut out the paper engineering ruler provided that has 150 divisions. Since the section of the map that includes point 1 is 2-1/2 minutes by 2-1/2 minutes or 150 seconds by 150 seconds, you will be able to use this ruler to find point one or any unknown point within a section. (Each division equals one second.)

   Using the ruler, locate any two points 44" (44 divisions) north of Lat N50'. You will need to hold the ruler vertically with the 0 mark on Lat N50' and the 150 mark on the top border of the map. (See Figure 5.)

   Connect the points. Point 1 is somewhere on this line.

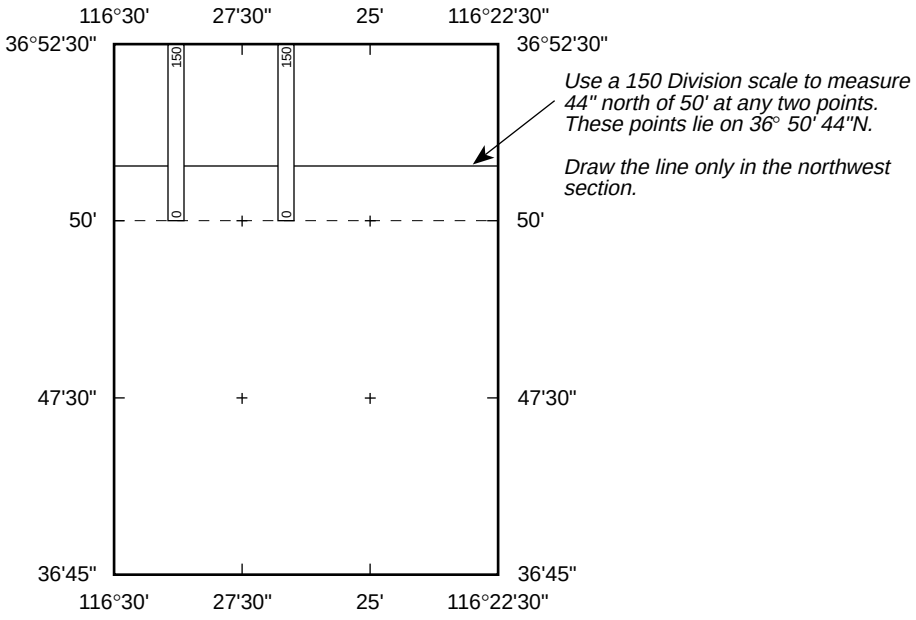


Figure 5

7. How many minutes west of the 27' 30" line of longitude is W116° 29' 24"?

   Minutes *(116° 29' 34" - 116° 27' 30" - 2'4")*

   Seconds *(2"4' = 124")*

You can subtract distances in degrees, minutes, and seconds but remember that you are working in base 60. One degree is equal to 60 minutes, and one minute is equal to 60 seconds.

8. Using the ruler, locate any two points 124" (124 divisions) west of Long W27' 30". This time you will need to hold the ruler diagonally as illustrated in Figure 6. It is important that you align either the 0 or 150 mark on the ruler with the 27' 30" line. You must align the other division mark (0 or 150) on the western boundary of the map. Count 124" west of 27' 30" and mark a point on the map. Although both ends of the ruler need to be aligned properly, they do not necessarily need to fall within the boundaries you have drawn for this section. Move the ruler, align it again, and make a second mark.

   Connect the two points making sure the line that connects them extends through the NW section of the map. Point 1 is where the line of longitude crosses the line of latitude you drew in step 6.

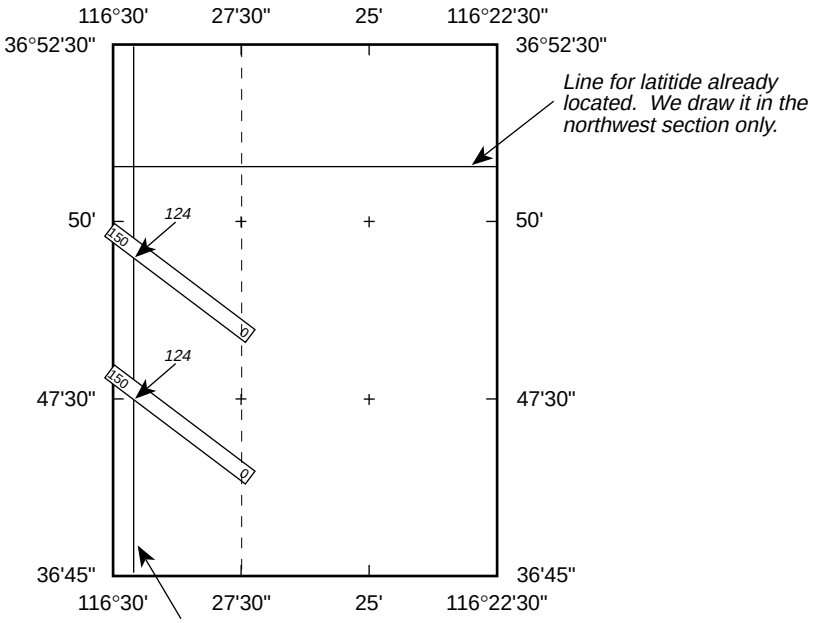


Figure 6

Point 2

9. Use the same approach to locate point 2.

   Using a blue pencil, connect points 1 and 2.

Part B: Drawing A Topographic Profile

If we could cut the Earth in half along the line that connects points 1 and 2, and then look at the planet's profile, we could clearly see peaks and valleys and get a good three-dimensional view of the topography of the land in this area. A much simpler way to gather the same information from a two-dimensional drawing is to construct a topographic profile.

1. What is the contour interval on your Busted Butte, Nevada, map?

   (Contour interval = 20 feet)

2. Using a sheet of paper that is at least 15" long on one side, align it so that the edge of the paper lines up with the line connecting points 1 and 2. (If necessary, tape two 8-1/2" x 11" sheets together.)

3. Make a mark on the paper where every dark brown (100) contour line crosses the line connecting points 1 and 2. (See Figure 7.) Record each line's elevation next to each mark. You may need to follow some contour lines quite a distance to determine their elevation. Where 100 contour lines are great distances apart, mark all others to get a greater degree of accuracy in your profile. Also record the location of jeep trails or roads where they cross the line of section.

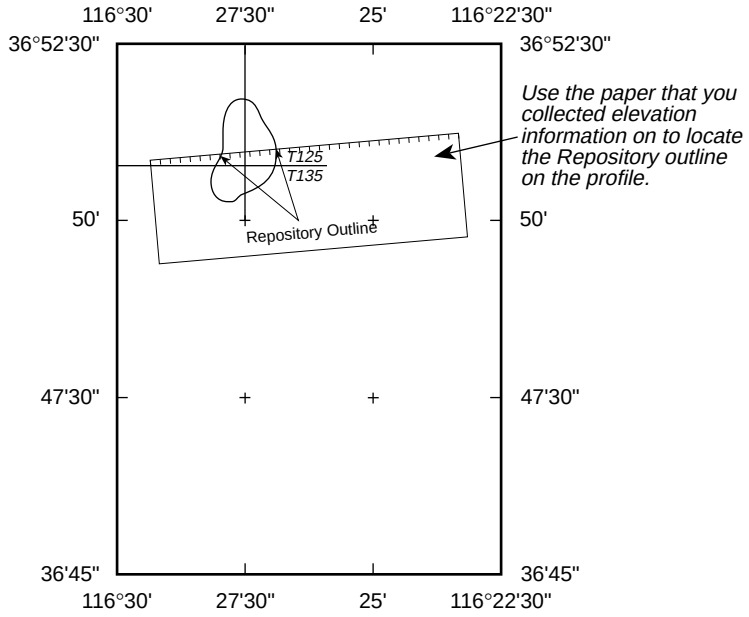
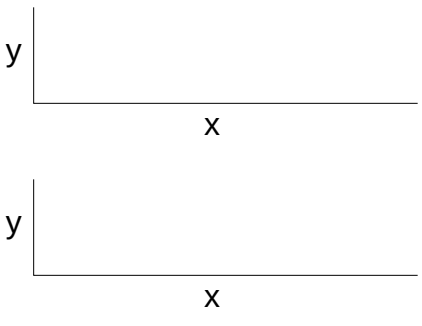


Figure 7

4. Tape two pieces of graph paper together so that the length of one edge is at least 15".

5. Draw two x and y axes on the graph paper as indicated below. The x-axis will represent the distance from point 1 to 2. The y-axis will represent different scales for each graph. One graph will have a scale of 1" = 500' while the other will have a scale of 1" = 2000'.



6. Line up the piece of paper that shows where contour lines cross the line connecting points 1 and 2, with the X-axis of your first graph as indicated below. At each mark along the X-axis, make a mark, at the appropriate elevation, as read on the y-axis. Do this for all points. Then connect the dots using a smooth line.

7. Repeat this procedure for the second graph using the second scale.

   What effect does the different vertical scale have on each profile?

   (The different scales enable you to see the same thing in two ways. The 1":500' scale shows sharper peaks. The 1":2000' scale looks flatter.)

   Which profile appears more like it would naturally occur?

   (An exaggerated profile is a way of magnifying the elevation data. This allows you to see more subtle changes in slope that you might miss on a profile drawn to scale.)

   Which profile emphasizes the subtle aspects of the surface along the profile by showing more details of the landscape?

   (1":500')

8. A pattern that represents the outline of the underground repository as it might appear in a final design is included. Cut out the pattern and use the lines drawn on the cut-out to locate it on the map. Transfer the shape to the map using a blue pencil. Now plot the locations on the topographic profile where the repository outline intersects the profile.

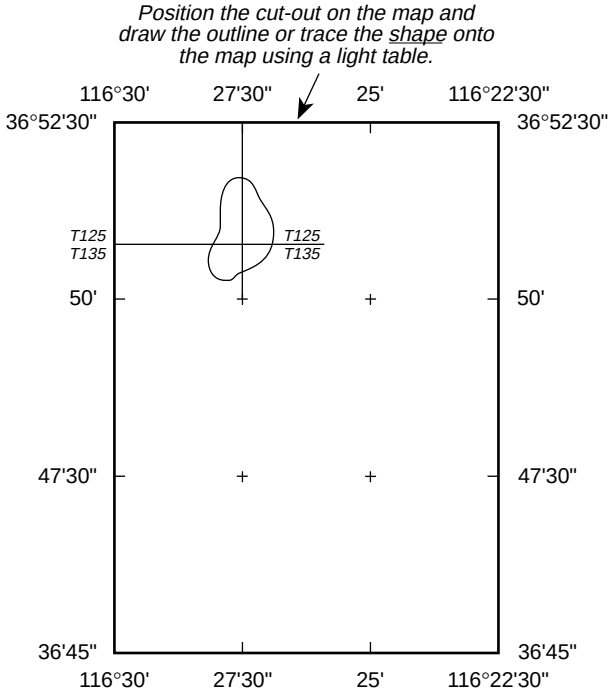
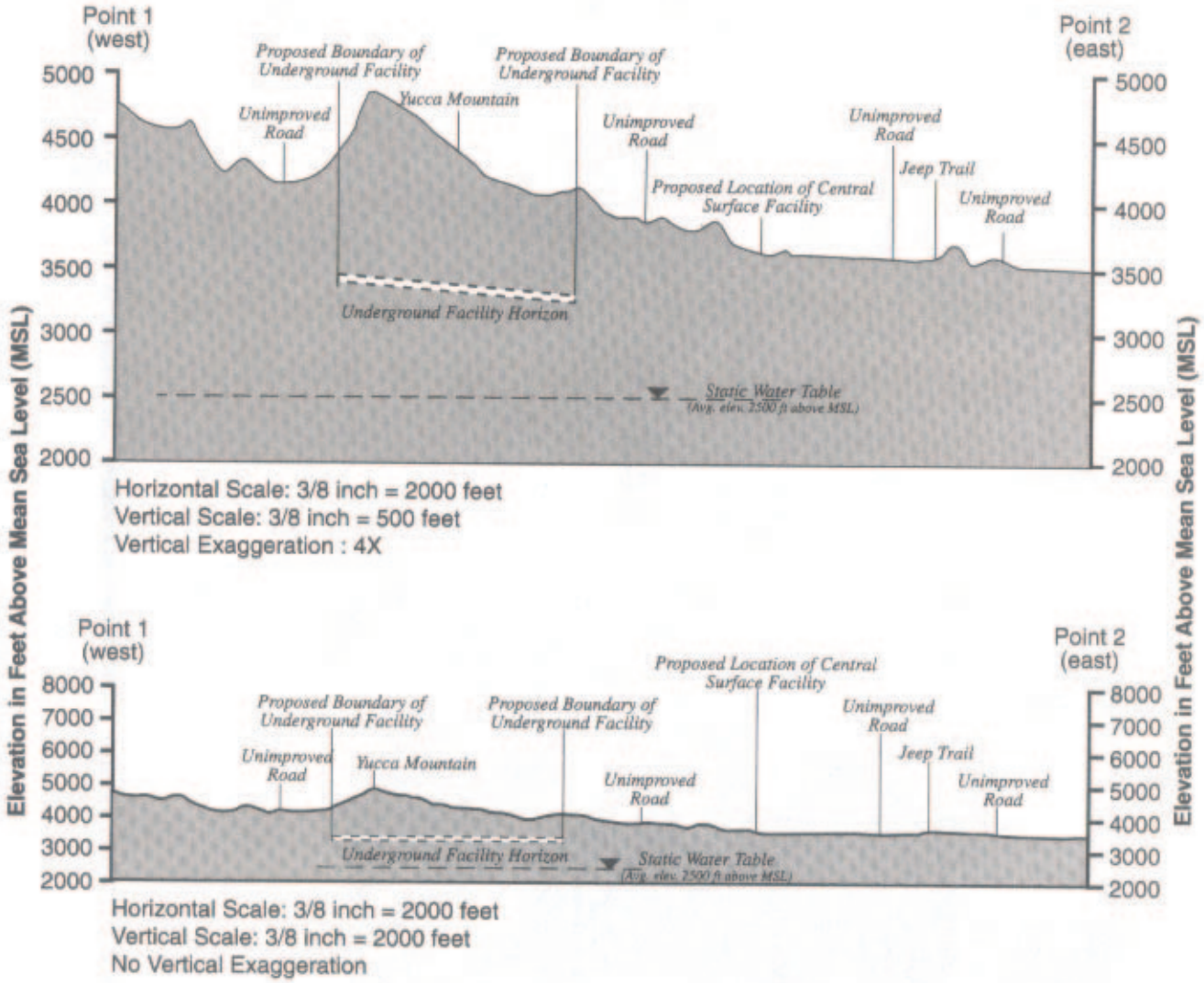


Figure 8

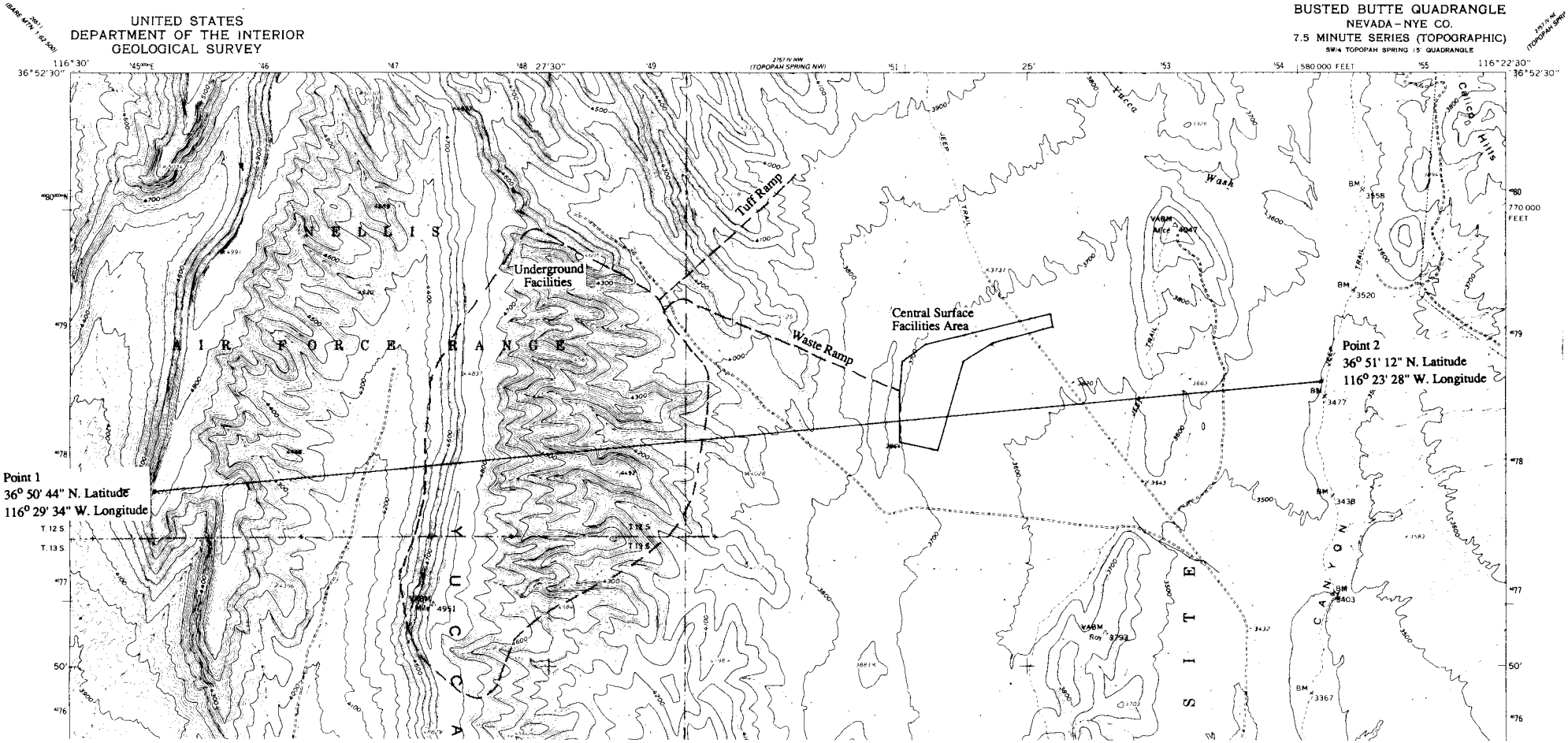
East-West Topographic Profiles Across Yucca Mountain



Since the vertical scale (VS) is larger than the horizontal scale (HS), the top profile is exaggerated. The vertical exaggeration (VE) of the profile is easily determined by the following relationship:

$$VE = \frac{HS}{VS}$$

where both the HS and VS are in the same units (i.e., feet, inches). The VE for the top profile is: 2000/500=4, which is written as 4X. The lower profile is said to have no VE since the HS and VS are equal (1inch = 2000 feet).


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BUSTED BUTTE QUADRANGLE
NEVADA – NYE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 TOPOPAH SPRING 15' QUADRANGLE
116°30'
116°22'30"
36°52'30"
580 000 FEET
770 000 FEET
NELLIS
AIR FORCE RANGE
Underground Facilities
Tuff Ramp
Waste Ramp
Central Surface Facilities Area
Point 1
36° 50' 44" N. Latitude
116° 29' 34" W. Longitude
Point 2
36° 51' 12" N. Latitude
116° 23' 28" W. Longitude
YUCCA
FLAT
SITE
Yucca
Wash
Calico Hills
CANYON
T. 12 S.
T. 13 S.
R. 48 E.
R. 49 E.

EROSION

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.4-2-5 Erosion

(a) *Qualifying Condition.*

The site shall allow the underground facility to be placed at a depth such that erosional processes acting upon the surface will not be likely to lead to radionuclide releases greater than those allowable under the requirement specified in Guideline 960.4-1. In predicting the likelihood of potentially disruptive erosional processes, the DOE will consider the climatic, tectonic, and geomorphic evidence of rates and patterns of erosion in the geologic setting during the Quarternary Period.

(b) *Favorable Conditions.*

(1) Site conditions that permit the emplacement of waste at a depth of at least 300 meters below the directly overlying ground surface.

(2) A geologic setting where the nature and rates of the erosional processes that have been operating during the Quarternary Period are predicted to have less than one chance in 10,000 over the next 10,000 years of leading to releases of radionuclides to the accessible environment.

(3) Site conditions such that waste exhumation would not be expected to occur during the first one million years after repository closure.

(c) *Potentially Adverse Conditions.*

(1) A geologic setting that shows evidence of extreme erosion during the Quarternary Period.

(2) A geologic setting where the nature and rates of geomorphic processes that have been operating during the Quarternary Period could, during the first 10,000 years after closure, adversely affect the ability of the geologic repository to isolate the waste.

(d) *Disqualifying Condition.*

The site shall be disqualified if site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface.

1. What is the lowest ground surface elevation along your topographical profile within the possible repository boundary?

   (The lowest ground surface elevation is 1,250 meters [4,100 feet].)

2. According to Favorable Condition (1) above, how deep should the repository be in meters? How many feet is this? (Remember that 1 meter = 3.28 feet.)

   (The repository should be 300 meters below the surface. 300 meters equals 984 feet.)

3. At what depth (in meters and feet) within the possible repository boundary could the repository be built to satisfy Favorable Condition (1)? Draw a line on your topographical profiles to represent this placement of the repository.

   (Since the lowest elevation within the boundaries is 1,250 meters [4,100 feet], the repository would need to be placed at about 950 meters [3,100 feet] to satisfy this condition.)

4. According to the Disqualifying Condition above, what is the minimum allowable depth for the repository in meters? How many feet is this?

   (The repository must be at least 200 meters below the surface. 200 meters equals 656 feet.)

5. At what depth (in meters and feet) within the possible repository boundary could the repository be built to satisfy the Disqualifying Condition? Draw a line on your topographical profiles to represent this placement of the repository.

   (The repository would need to be placed at or below 1,006 meters [3,300 feet].)

6. Calculate the maximum rate of erosion that would uncover a repository at a depth of 200 meters, and a repository at 300 meters, during a time span of 10,000 years.

(200 meters = 0.02 meters/year = 2 centimeters/year
10,000 years

300 meters = 0.03 meters/year = 3 centimeters/year
10,000 years)

GROUND WATER

1. According to a hydrologic atlas published by the U.S. Geological Survey:

   1) The State of Nevada has a mean precipitation of 9 inches per year, the lowest statewide mean in the United States.

   2) An average of less than 1 inch of this precipitation either recharges aquifers or runs off.

   3) In 84 percent of the State, drainage is to low areas in enclosed basins rather than to the sea. Flow in the larger rivers generally decreases downstream as water is lost to evaporation and infiltration.

Directions: Use these three facts and the topographic map, as necessary, to answer the questions below.

a. Of the 9 inches of annual precipitation, how much is evaporated?

(Since an average of 1 inch infiltrates, then 8 inches evaporate.)

b. Examine the topographic map looking for evidence of running water (runoff). What do you think the blue dashed and dotted lines represent?

(The blue dashed and dotted lines represent intermittment flow of water that occurs when runoff exceeds losses from evaporation and infiltration.)

c. Look at the area east of Yucca Mountain toward Fortymile Canyon and Fortymile Wash. What happens to runoff from Yucca Mountain when it reaches Fortymile Wash, southeast of Busted Butte?

(Only runoff from intense rainstorms reaches Fortymile Wash. Eventually it will evaporate and infiltrate. There are no continuously flowing streams and/or rivers that reach the ocean or a permanent lake from this part of Nevada.)

d. Explain why you think flow decreases downstream, rather than increases, in this area of the country.

(Streamflow decreases because more water is lost due to infiltration and evaporation than is contributed by rainfall.)

e. Use an almanac or other reference book to find the mean annual precipitation for the State of South Carolina. What is the annual precipitation? Why do you think streams and rivers flow continuously in this State even during long periods without rainfall?

(The mean annual precipitation for South Carolina is about 50 inches/year. This volume creates a surplus of water that is carried to the ocean in continuously flowing streams. Groundwater inflow from the saturated zone supplies much of the surplus water.)

2. One of the important considerations in siting the repository is the elevation of the water table. The water table separates the saturated zone from the unsaturated zone. Examine Figure 10, which shows how water is obtained from wells drilled into the saturated zone beneath the surface of the ground. Assume Figure 10 represents conditions as they exist in this part of Nevada. Now look in the southeast corner of the Busted Butte topographic map for Well J-12. At what surface elevation is Well J-12? Based on the evidence provided by the topographic map alone, what is the maximum depth of the water table in this region?

(Well J-12 is at elevation 3,130 feet. The water table elevation must be 3,130 feet at the most.)

3. What are other indications of the depth of the water table?

(Other areas of low elevation, lack of running water.)

4. Do any of the items you listed in question 3 suggest that the water table is deeper than what was suggested by the location of Well J-12?

(Yes. There is a coutour near Fortmile Wash at 3,120 feet.)

5. Using the water table elevation that you determined in question 2, draw a line at this elevation across the entire length of the topographic profiles that you prepared and label it “MAXIMUM POSSIBLE WATER TABLE ELEVATION BASED ON WELL J-12."

6. What assumptions are we making when we draw this line?

(This line is only a guess about the elevation of the water table along the profile line. This is why it should be clearly labeled as directed. We assume (1) the conditions in the Well J-12 area are the same as in the NW corner of the map, and (2) the water table is at a constant elevation.)

7. How certain are you that this line represents a real water table elevation?

(Answers will vary, but should indicate that we cannot be certain.)

8. Why draw this line at all?

(We draw this line as an educated guess. It might give us some ideas about determining the true elevation of the water table.)

9. How would you obtain a much more precise value for the elevation of the water table in the vicinity of Well J-12? How would you obtain a much more precise depth for the water table along the topographic profile that you drew?

(The water table elevation can be determined by measuring the depth to the water in Well J-12. To obtain the water elevation along the line of profile, it would be necessary to drill wells at various locations along the line of profile and measure the depth of the water table.)

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.4-2-1 Geohydrology

(a) *Qualifying Condition.*

The present and expected geohydrologic setting of a site shall be compatible with waste containment and isolation. The geohydrologic setting, considering the characteristics of and the processes operating within the geologic setting, shall permit compliance with

(1) the requirements specified in 960.4-1 for radionuclide releases to the accessible environment and

(2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology.

(b) *Favorable Conditions.*

(1) Site conditions such that the pre-waste-emplacement ground-water travel time along any path of likely radionuclide travel from the disturbed zone to the accessible environment would be more than 10,000 years.

(2) The nature and rates of hydrologic processes operating within the geologic setting during the Quaternary Period would, if continued into the future, not affect or would favorably affect the ability of the geologic repository to isolate the waste during the next 100,000 years.

(3) Sites that have stratigraphic, structural, and hydrologic features such that the geohydrologic system can be readily characterized and modeled with reasonable certainty.

(4) For disposal in the saturated zone, at least one of the following pre-waste-emplacement conditions exist:
   (i) A host rock and immediately surrounding geohydrologic units with low hydraulic conductivities.
   (ii) A downward or predominantly horizontal hydraulic gradient in the host rock and in the immediately surrounding geohydrologic units.
   (iii) A low hydraulic gradient in and between the host rock and immediately surrounding geohydrologic units.
   (iv) High effective porosity together with low hydraulic conductivity in the rock units along paths of likely radionuclide travel between the host rock and accessible environment.

(5) For disposal in the unsaturated zone, at least one of the following pre-waste-emplacement conditions exists:
   (i) A low and nearly constant degree of saturation in the host rock and in the immediately surrounding geohydrologic units.
   (ii) A water table sufficiently below the underground facility such that the fully saturated voids continuous with the water table do not encounter the host rock.
   (iii) A geohydrologic unit above the host rock that would divert the downward infiltration of water beyond the limits of the emplaced waste.
   (iv) A host rock that provides for free drainage.

(v) A climatic region in which the average annual historical precipitation is a small fraction of the average annual potential evapotranspiration.

(c) *Potentially Adverse Conditions.*

(1) Expected changes in geohydrologic conditions—such as changes in the hydraulic gradient, the hydraulic conductivity, the effective porosity, and the ground water flux through the host rock and the surrounding geohydrologic units—sufficient to significantly increase the transport of radionuclides to the accessible environment as compared with pre-waste-emplacement conditions.

(2) The presence of ground water source, suitable for crop irrigation or human consumption without treatment, along ground water flow paths from the host rock to the accessible environment.

(3) The presence in the geologic setting of stratigraphic or structural features—such as dikes, sill, faults, shear zones, folds, dissolution effects, or brine pockets—if their presence could significantly contribute to the difficulty of characterizing or modeling the geohydrologic system.

(d) *Disqualifying Condition.*

A site shall be disqualified if the pre-waste-emplacement ground water travel time from the disturbed zone to the accessible environment is expected to be less that 1,000 years along any pathway of likely and significant radionuclide travel.

10. Pretend that the water table elevation on your topographic profile is accurate. Do you think the repository elevations on your profile are favorable according to the geohydrology guidelines?

(The purpose of these questions is to allow students to think about the information presented in the activity and wrestle with one of the more complex guidelines. The students may not understand all of the terms in the geohydrology guidelines.)

11. Section (b)(5) lists pre-waste-emplacement conditions for the unsaturated zone. Which, if any, of these conditions exist at Yucca Mountain according to your profile and the information you have acquired in this activity? Explain your answers.

(Of the five conditions under section (b)(5), the student should be able to argue that condtions (ii) and (v) are present. Valid arguements can also be made for the presence of the other conditions, especially if the student has completed and understood the activity Rock Characteristics Important in Repository Siting.)

12. Based on your calculated water table, if the repository were sited for an elevation of 1,021 meters (3,350 feet), would it be located in the saturated or unsaturated zone?

(Probably in the unsaturated zone.)

13. Would a repository at 1,021 meters (3,350 feet) conflict with the erosion or the geohydrology guidelines? Why or why not?

(It would be very near the 200 meter [656 feet] minimum depth limit in the erosion guidelines.)

14. Based on your determined water table, if the repository were sited for an elevation of 884 meters (2,900 feet), would it be located in the saturated or unsaturated zone?

(It would be located in the unsaturated zone.)

15. Would a repository at 884 meters (2,900 feet) conflict with either the erosion or the geohydrology guidelines? Why or why not?

(No. The repository would be well below the favorable 300 meter [984 feet] depth, and it would still be in the unsaturated zone.)

16. Suppose you had to choose between putting the repository at 1,021 meters (3,350 feet) or at 884 meters (2,900 feet) and assume that the water table elevation on your profile is accurate. In making your decision, how would you balance the requirements of the erosion and geohydrology guidelines?

(The purpose of this question is to stimulate thought about trade offs that might have to be made in siting the repository. The student should notice that a repository at 1,021 meters [3,350 feet] is well within the unsaturated zone, but is very near the 200 meter [656 feet] minimum depth limit. The repository at 884 meters [2,900 feet] is below the favorable 300 meter [984 feet] depth, but is in the saturated zone.)

The water table under Yucca Mountain occurs in the fractured tuff of the Calico Hills or the Crater Flat units; it slopes to the southeast from an elevation of 792 to 732 meters (2,600 to 2,400 feet) above sea level. Current estimates are that only a small part of the rain that falls on Yucca Mountain percolates through the matrix of the unsaturated zone. The regional direction of ground water flow is south to southwest. As elsewhere in the southern Great Basin, the ground water basins tend to be closed, with no external drainage into rivers or major bodies of surface water. (Source: Consultation Draft Site Characterization Plan Overview Yucca Mountain Site, Nevada Research and Development Area, Nevada DOE/RW-0161, 1988.)

POPULATION DENSITY AND DISTRIBUTION

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.5-2-1 Population Density and Distribution

(a) *Qualifying Condition.*

The site shall be located such that, during repository operation and closure,

(1) the expected average radiation dose to members of the public within any highly populated area will not be likely to exceed a small fraction of the limits allowable under the requirements specified in 960.5-1(a)(1), and

(2) the expected radiation dose to any member of the public in an unrestricted area will not be likely to exceed the limit allowable under the requirements specified in 960.5-1(a)(1).

(b) *Favorable Conditions.*

(1) A low population density in the general region of the site.

(2) Remoteness of site from highly populated areas.

(c) *Potentially Adverse Conditions.*

(1) High residential, seasonal, or daytime population density within the projected site boundaries.

(2) Proximity of the site to highly populated areas, or to areas having at least 1,000 individuals in an area 1 mile by 1 mile as defined by the most recent decennial count of the U.S. census.

(d) *Disqualifying Conditions.*

A site shall be disqualified if-

(1) Any surface facility of a repository would be located in a highly populated area; or

(2) Any surface facility of a repository would be located adjacent to an area 1 mile by 1 mile having a population of not less than 1,000 individuals as enumerated by the most recent U.S. census; or

(3) The DOE could not develop an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 (Reactor and Non-Reactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations) and related guides or, when issued by the NRC, in 10 CFR Part 60, Subpart I, “Emergency Planning Criteria.”

1. Nevada has a 1980 population of 799,000 and a land area of 109,889 square miles. What is the population density of the State?

   (The population density is the number of people in the State divided by the land area of the State: 1,201,832 persons divided by 109,889 square miles = 10.9 persons per square mile.)

2. According to the population density guidelines sections (a) and (b), what other information would you need to determine if the Yucca Mountain site is in a region of low population density?

   (You would want to know the distance to nearby cities, communities, or homes and their respective populations.)

3. Examine the topographic map for habitable structures and estimate the population density of the area covered by the map. (The area of the map is approximately 59 square miles.)

   (No habitable structures appear on the map except for two buildings near the eastern edge of the map. If we assume these buildings are pump houses or storage sheds, then the population of the area is zero. If one of your students argues that these buildings may be occupied continuously by security or maintenance personnel, a reasonable estimate might be three persons in each building. The area of the map is approximately 59 square miles. Therefore, the population density would be 0.1 person per square mile. Note that even 30 people in each building would yield a population density of only 1 person per square mile. The area of the map can be determined by measuring the distance along the long and short border in feet, converting to miles, and multiplying 1 mile = 5,280 feet.)

SITE OWNERSHIP AND CONTROL

Directions: Read the excerpt from the *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.5-2-2 Site Ownership and Control.

(a) *Qualifying Condition.*

The site shall be located on land for which the DOE can obtain, in accordance with the requirements of 10 CFR 60.121, ownership, surface and subsurface rights, and control of access that are required in order that surface and subsurface activities during repository operation and closure will not be likely to lead to radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in 960.5-1(a)(1).

(b) *Favorable Condition.*

Present ownership and control of land and all surface and subsurface mineral and water rights by DOE.

(c) *Potentially Adverse Condition.*

Projected land-ownership conflicts that cannot be successfully resolved through voluntary purchase-sell agreements, nondisputed agency-to-agency transfers of title, or Federal condemnation proceedings.

1. Who controls most of the land area of the Busted Butte Quadrangle map?

(The black-dash dot symbols that partition most of the map represent national or State park, reservation, or monument boundaries.)

2. Can you determine the ownership of all of the land area on the map?

(No.)

3. Will the proposed repository site meet the ownership and control guidelines? Why or why not?

(It will if this area is located on national reserve. State-owned reserve may be a potentially adverse condition. In fact, the land where the candidate site is located is Federally owned/ controlled.)

CROSSWORD PUZZLE